Methane Pyrolysis for Hydrogen & Carbon Nanotube Recovery from Sabatier Products, Phase II

Completed Technology Project (2005 - 2007)

Project Introduction

Development of a microgravity and hypogravity compatible catalytic methane pyrolysis reactor is proposed to recover hydrogen which is lost as methane in the conversion of carbon dioxide to water via the Sabatier process. This will close the hydrogen loop which currently requires 50% resupply and also produce carbon nanotubes, a high value product which may be employed as an adsorbent or catalyst for removal of atmospheric trace contaminants, thus further lowering the resupply burden for manned spacecraft. Microgravity compatibility of Gradient Magnetically Assisted Fluidized Beds (GMAFB) has been demonstrated through a series of KC135 flight experiments. Metallic cobalt, which has been fluidized in microgravity using the GMAFB method, is an excellent catalyst for promotion of methane pyrolysis. Recently, fluidized bed catalytic methods have been shown to efficiently recover hydrogen, and produce single walled carbon nanotubes. Using the GMAFB method, this process can be rendered totally compatible with operation in the microgravity of spaceflight or the reduced gravity of planetary environments. By recovering all of the hydrogen which is lost as methane in the Sabatier reactor, the requirement for production or resupply of hydrogen is reduced to the absolute minimum. Development of a microgravity and hypogravity compatible catalytic methane pyrolysis reactor is proposed to recover hydrogen which is lost as methane in the conversion of carbon dioxide to water via the Sabatier process. This will close the hydrogen loop which currently requires 50% resupply and also produce carbon nanotubes, a high value product which may be employed as an adsorbent or catalyst for removal of atmospheric trace contaminants, thus further lowering the resupply burden for manned spacecraft. Microgravity compatibility of Gradient Magnetically Assisted Fluidized Beds (GMAFB) has been demonstrated through a series of KC135 flight experiments. Metallic cobalt, which has been fluidized in microgravity using the GMAFB method, is an excellent catalyst for promotion of methane pyrolysis. Recently, fluidized bed catalytic methods have been shown to efficiently recover hydrogen, and produce single walled carbon nanotubes. Using the GMAFB method, this process can be rendered totally compatible with operation in the microgravity of spaceflight or the reduced gravity of planetary environments. By recovering all of the hydrogen which is lost as methane in the Sabatier reactor, the requirement for production or resupply of hydrogen is reduced to the absolute minimum.

Anticipated Benefits

A commercial application with extremely high economic potential is the production of carbon nanotubes (CNTs). CNTs are nanomaterials with unusually high strength, low density, excellent electrical conductivity, and other properties with numerous potential applications including: as nanometer sized semiconductor components and devices, field emission displays, hydrogen storage, sensors, energy storage and energy conversion devices, catalysts, conductive and high strength composites. Currently prices for CNT

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

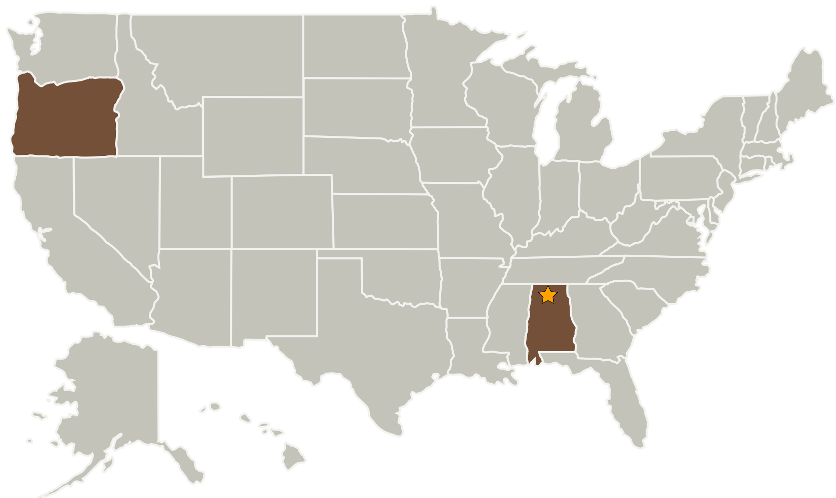
Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer range from $30/gram to $2,000/gram, owing to the lack of methods for large-scale synthesis. The proposed technology will help to overcome this limitation. The NASA application of this technology will be as Flight Hardware for deployment in support of future long duration exploration objectives such as a lunar mission, lunar base, Mars transit or Mars base. The primary application will be for the recovery of hydrogen lost in the Sabatier process for CO_2 reduction to produce water in Advanced Life Support systems. Secondarily, this process may also be used in conjunction with a Sabatier reactor employed for propellant and fuel production from Martian atmospheric CO_2.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
UMPQUA Research Company	Supporting Organization	Industry	Myrtle Creek, Oregon

Primary U.S. Work Locations	
Alabama	Oregon

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Robyn Carrasquillo

Principal Investigator:

James Atwater

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - └ TX06.1 Environmental Control & Life Support Systems (ECLSS) and Habitation Systems
    - └ TX06.1.1 Atmosphere Revitalization